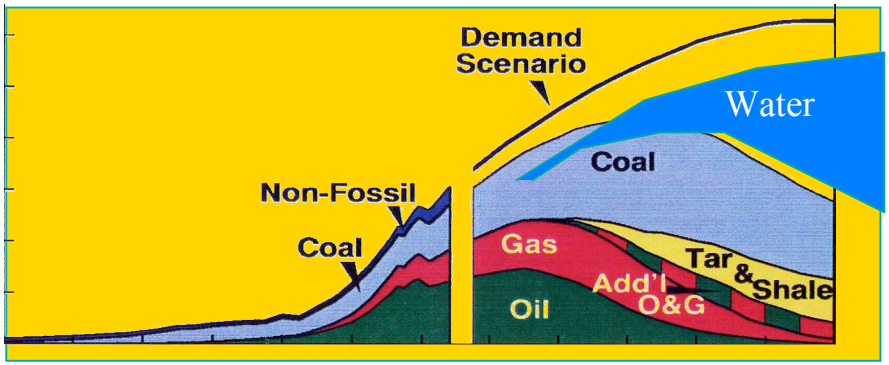
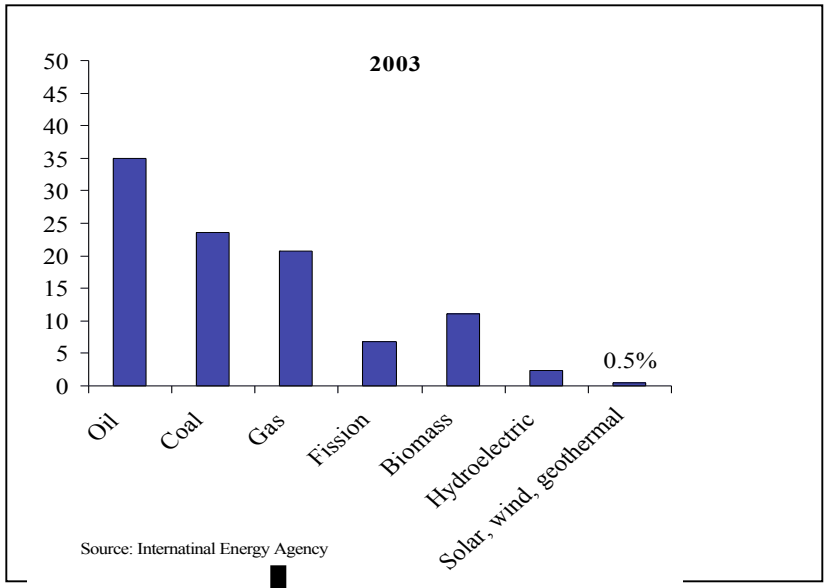
Geosciences Research Initiative

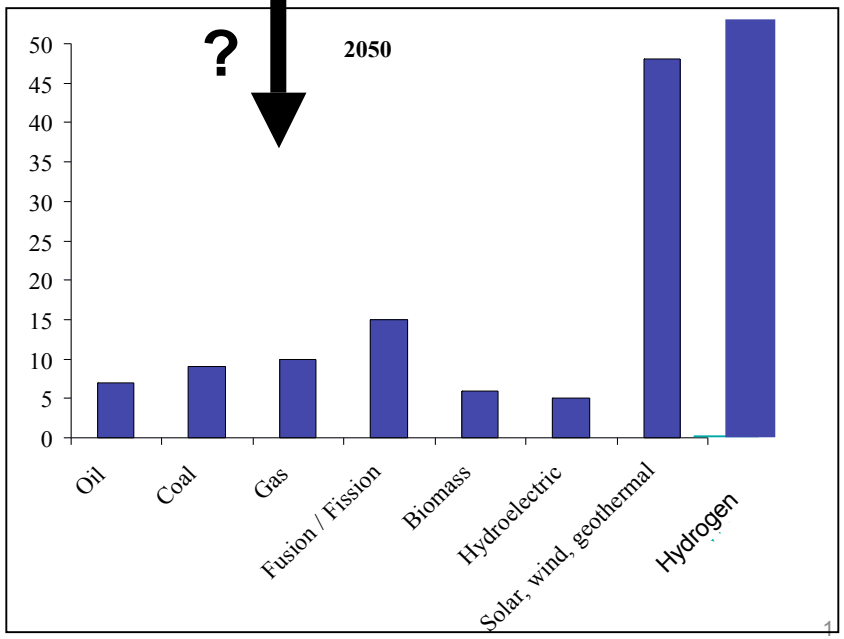




All technologies envisioned to meet future energy and environmental demands require advances in fundamental Geo/environmental sciences:

- *** Fossil (oil, gas, coal)**
- *** Nuclear**
- *** Hydrogen**
- *** Biomass**
- *** Renewable (wind, solar geothermal)**
- *** Water supply**

(modified from R. E. Smalley, Rice University BES Symposium 4/29/03)



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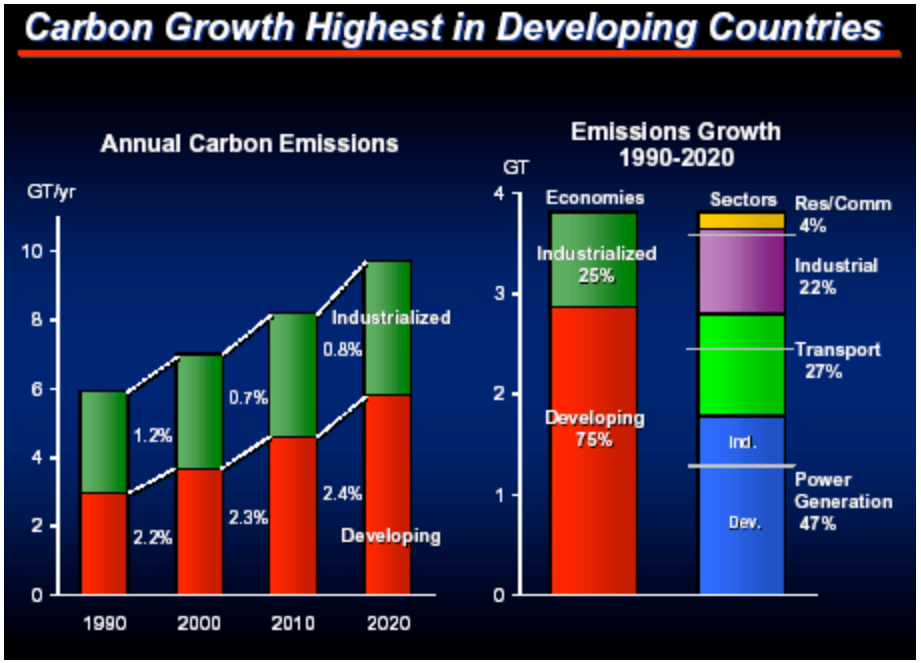
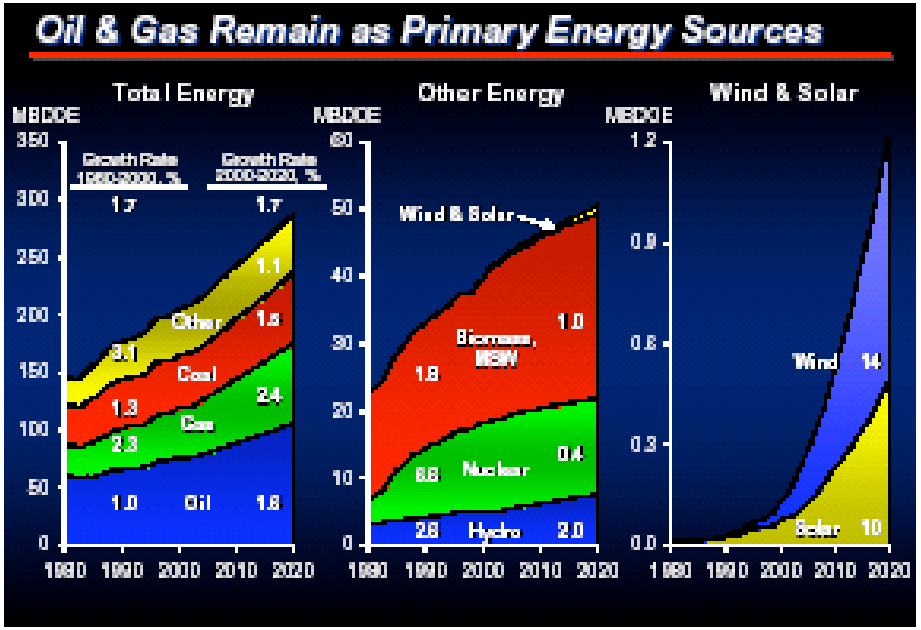
Needs

WE ARE RUNNING OUT OF TIME!!

- Increasing evidence that we will soon face a "resource gap" in energy and environmental security
  - Developing countries will be major consumers of conventional resources
  - Environmental consequences of energy production will increase not decrease
  - Result will be more reliance on political rather than technical solution
- Current mode of research in the geosciences will not provide breakthroughs in time to avoid major economic disruptions
  - Must augment individual PI driven research with focused crosscutting research teams to transfer the results from "lab" to field
  - Choose unifying topics for leveraged research
  - Transfer results to end users of technology





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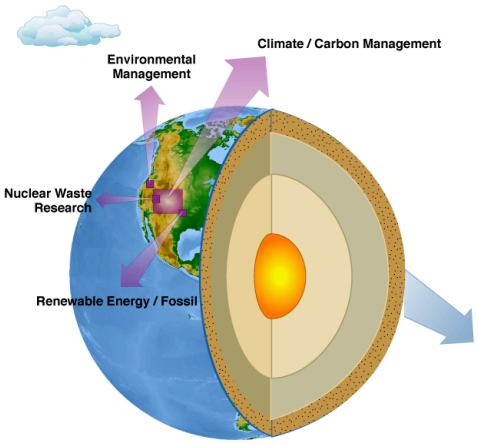
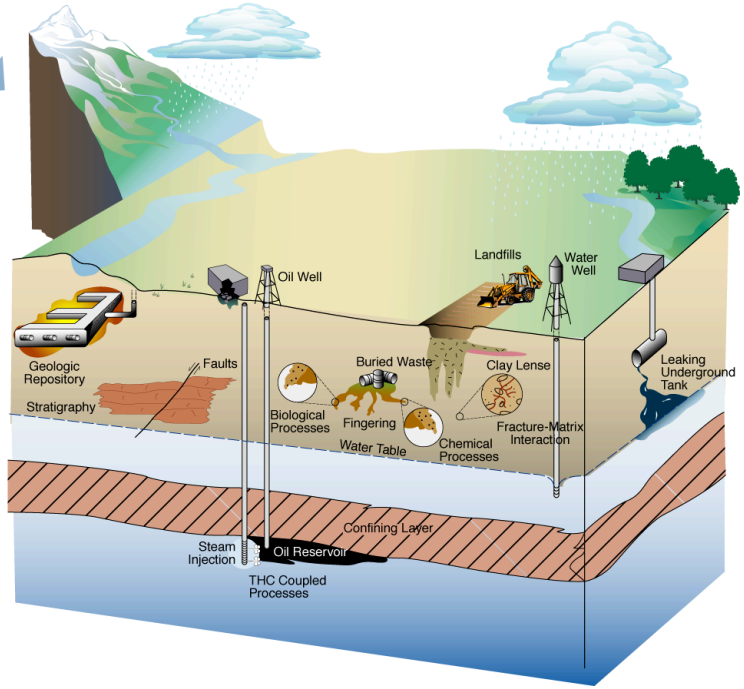
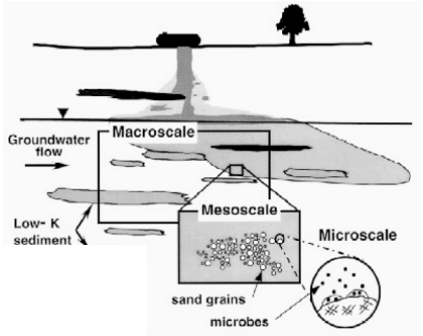
Long Term Goals: Develop fundamental understanding of crosscutting, complex, coupled processes that will permit imaging and manipulation of the ecosphere for improved management and exploitation

* sustainable resource development (water, fossil fuels CO2 Sequestration)
* environmental remediation
* climate change prediction
* safe nuclear waste disposal

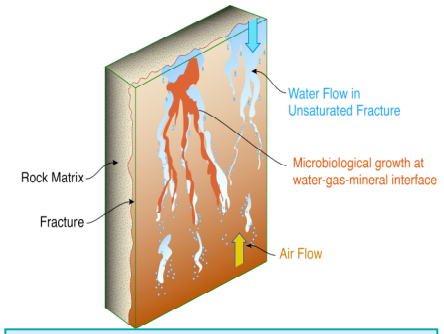


Cross-cutting DOE Geosciences Initiatives

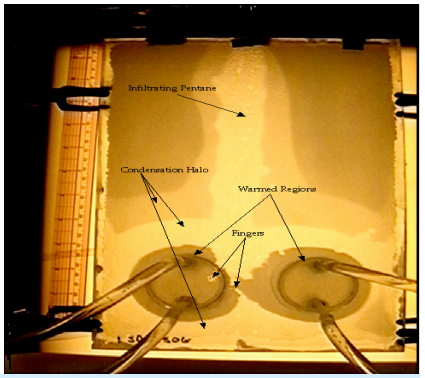




Scaling



Process Prediction



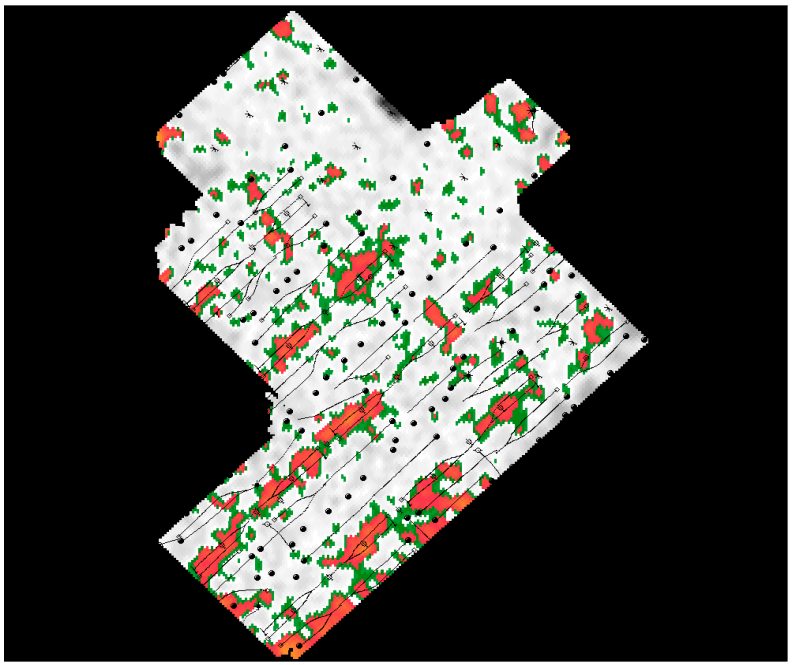
Ecosphere Manipulation

Major Obstacles – Energy production

- Accurate location and identification of fluids (fluid imaging)
  - Phase and partitioning (oil, gas , brine, steam, etc)
  - Quantity
  - Transport mechanisms/rates
- Efficient extraction
  - Drilling efficiency and location
  - Drilling hazards
  - Borehole life

Major Obstacles – CO2 Sequestration

- Accurate location and identification of CO2 and transport mechanisms
  - Phase and partitioning (oil, gas , brine, CO2, etc)
  - Leakage paths and rates
- Efficient and cost effective containment
  - Total volume and rates of injection
  - Borehole/ reservoir life
  - Monitoring requirements



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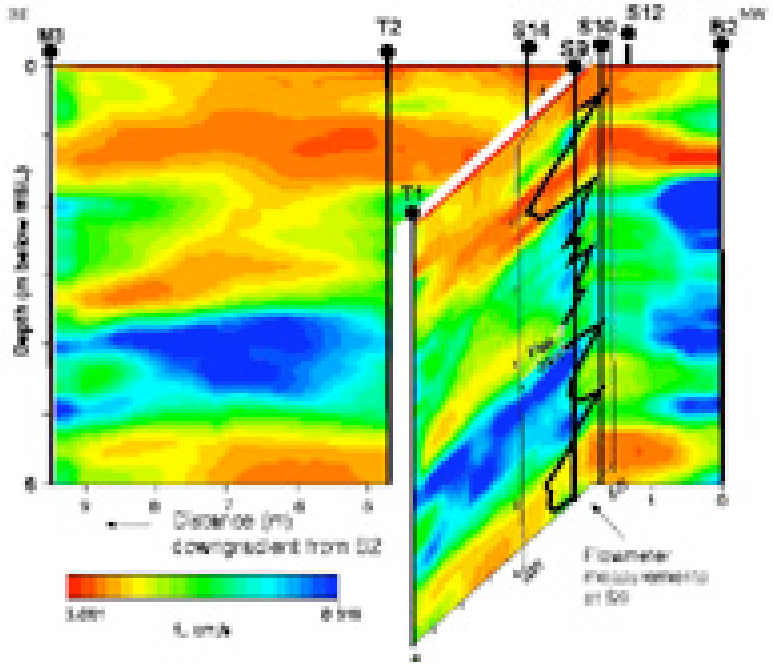
Major Obstacles – Nuclear Waste Disposal

- Accurate location and identification of fluid transport mechanisms and pathways
  - Fast pathways versus matrix transport
  - Quantity of fluids
  - Transport/Retardation mechanisms
- Long term prediction of System response due to perturbation of the natural system
  - Effect of waste package and mining/ Drilling

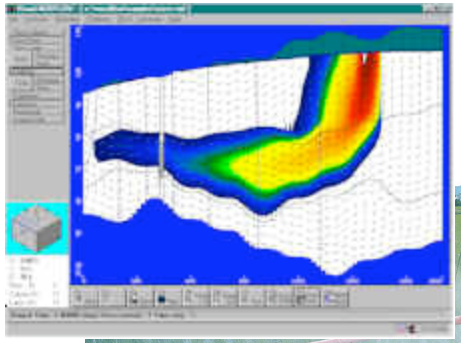
Major Obstacles – Environmental Remediation

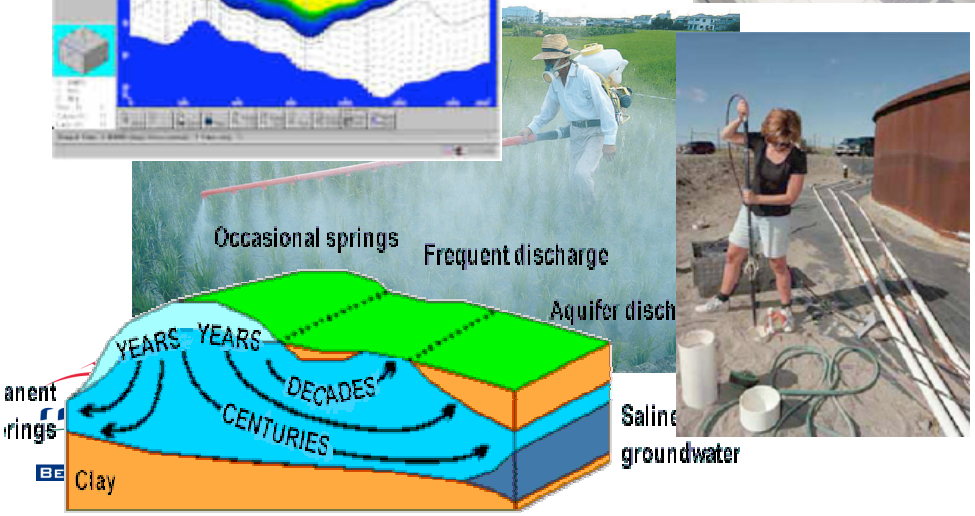
- Accurate location and identification of fluids and contaminants
  - Phase and partitioning (DNAPL, water, gas , metals, RN,. etc)
  - Relative quantities
  - Transport mechanisms
- Efficient extraction and/or remediation
  - Manipulation of physical chemical and microbial conditions
  - Coupled processes understanding
- Long term performance
  - Leakage/containment

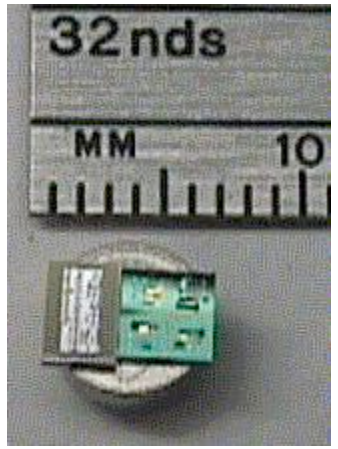


Crosscutting Obstacles

- next generation **sensor** development and emplacement
- **imaging** and multi-scale, multi-sensor data integration
- model **prediction** of processes over various length and time scales and **uncertainty** quantification
- **ecosphere manipulation** for sustainable resource development and environmental remedation

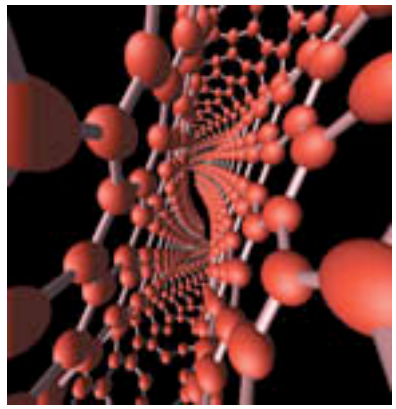


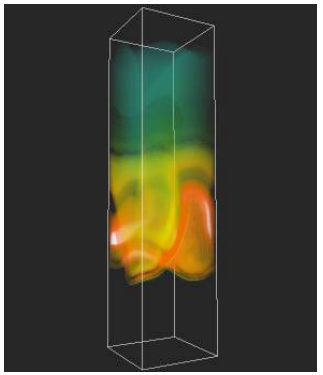


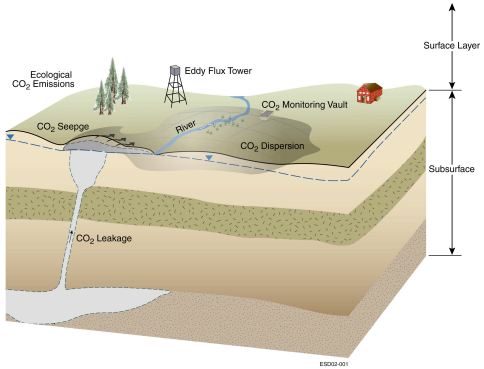


Implementation Mechanism

- Major research facilities focused on critical crosscutting issues
  - Eliminate major roadblocks for improving current and advanced energy production
  - Balance adequate environmental protection with economic growth
  - Use natural analogs for complex process understanding
- Draw on unique expertise and form critical mass through integrated “Manhattan” style projects
  - Nano-scale to macro-scale
  - Integrate diverse expertise to supply innovative and cost effective solutions







Major Impacts

- Drastic increase in oil and gas recovery
- Safe and economic CO_2 sequestration
- Safe and defensible disposal of nuclear waste disposal
- Sound basis for management and protection of water resources
- Efficient and reliable environmental cleanup
- Reliable and defensible predictions of Climate Change
- Drastically improved use of renewable energy
- Sound fundamental basis for transition to hydrogen economy

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Path Forward

- Form Advisory Committee
- Present concept to NRC workshop to target agencies
- Organize series of workshops on defining critical crosscutting issues
- Formulate “proposal” for submittal to participating programs.
- Initiate research teams in targeted research areas

Summary

- For the next 50 years we will be in a carbon constrained energy supply
  - Broad implications on current domestic resources and economic vitality
- We must smoothly transition to other energy sources
  - Optimize current domestic resources while developing new ones (no magic bullets)
- Fundamental geoscience research is critical for supporting every envisioned technology essential for this transition
- We are running out of time, new paradigms must be developed for meeting the challenge
  - Link fundamental research to applied needs
  - Form critical mass in selected projects to address major roadblocks